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AIRCRAFT CIRCULARS

NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

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AVRO C.30 DIRECT-CONTROL AUTOGLIRO (BRITISH)

By C. N. Colson

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By C. N. Colson

Now that the Avro C.30 type autogiro has reached the production stage, we are able to publish the first authoritative description of its construction (figs. 1, 2, and 3).

Like all Avro airplanes the fuselage is built up of welded steel tubes. The front and rear halves are made up separately, the division being at the bulkhead behind the rear, or pilot's cockpit (figs. 4 and 5). In both cases the sides of the fuselage are welded up on flat, table-like jigs, and subsequently the two sides are placed in their correct relation to one another in a vertical jig and the cross struts welded in. In the rear half the diagonal bracing between the two longerons in a horizontal plane is by the Avro method of forming a continuous loop of piano wire by passing it through small curved pieces of steel-tube welded into each corner, and joining the ends with a wire strainer. The diagonal bracing in the vertical plane is rigidly built up with tubes. The front half is entirely tube-braced. Wherever possible, jigs are used both in order to insure accuracy and to cheapen production. Consequently, there are not only jigs for welding, but also for drilling, as, for example, at the four attachment points where the legs of the rotor pylon join the top longerons.

After the main part of the fuselage has been erected, the sternpost and fins are welded on and the whole is stove-enamedled. The fins, although in reality, continuous, may be considered as three in number: The fin on top of the fuselage; the tail fin which, like the others, is fixed and occupies the same position as the rudder in a normal airplane; and the fin underneath the fuselage. All are built up of small-diameter steel tubes welded together.

The fuselage, from the front of the front cockpit to the tail, is encircled with plywood formers (fig. 6) carrying numerous thin spruce stringers running fore and aft

*From Flight, August 2, and 9, 1934.

and forming a framework over which a doped fabric covering is secured. This fabric is only carried up to the top longerons in the front half of the fuselage, as the decking over the two cockpits is a separate structure of plywood. The engine bay, and the sides and top of the fuselage in the bay behind the fireproof bulkhead, are covered with detachable aluminum panels secured with Avro cowling clips.

The engine mounting consists of steel tubes bolted to fittings at the ends of the four longerons, carrying at the front a ring which registers with the back plate of the engine. The 7-cylinder Armstrong-Siddeley Genet Major engine, developing 140 horsepower at 2,200 r.p.m., is thereby mounted outside the line of the cowling in a very accessible position, but the drag is kept low by the smooth curve of the cowling behind it. A collector ring with a single downward-facing outlet carries away the exhaust. Fuel is carried in a 23-gallon welded aluminum tank, strapped in position above the top longerons in the bay directly behind the fireproof bulkhead, which is of the normal sheet aluminum and asbestos construction. Mounted on the front of this bulkhead is the oil tank, of 3-gallon capacity, and also of welded aluminum. The throttle controls are the push-and-pull type with duralumin rods.

Wooden construction is used in the tail plane, which has spindled spruce spars, plywood ribs, and spruce strut drag bracing, the whole being covered with doped fabric. This unit is interesting as the camber on the port side is reversed to counteract the engine torque reaction (fig. 9). At each end of the tail plane there are upturned tips of fairly large dimensions which serve to keep the autogiro on a straight course and also to give it the necessary stability in turns. The trailing edges of these tips and those of the tail plane are in the form of flaps which may be adjusted by means of a small screw for the purpose of trimming the aircraft.

A tail wheel is carried in a compression strut and fork and has a 270 by 100 mm (10.63 by 3.94 in.) tire. It is very neat and yet at the same time amply sprung for the heavy loads imposed upon it during typical autogiro landings. It is steerable by cables from a cross foot-bar in the pilot's cockpit.

The two cockpits are well fitted with the usual instruments, map cases, and so on, and the sheet aluminum

seats are dished to take service type parachutes. A plywood floor extends the length of both cockpits and is bolted to small corner pieces of steel plate welded on to the fuselage between the cross bracing and the longerons. The front cockpit has a sliding door on the port side.

Wide outriggers of pyramid form, which carry the top ends of the Avro oil-and-spring landing gear compression legs, appear rather massive, but it must be remembered that autogiro landings impose greater stresses on this particular part of the structure than do the less vertical landings of the normal airplane. The upper pyramids are built of streamline-section steel tube, and the axle radius rods, as well as the compression legs, are faired to streamline shape with balsa-wood fairings; consequently, the drag should not be unduly high. The assembly in detail is given in figure 7.

Now we come to what may be termed the "autogiratory" part of this flying machine. The rotor system consists of a 3-blade rotor revolving about a massive head mounted on a form of universal joint, so that it can be tilted in any direction by a control column (fig. 8). This control column is "hanging" as opposed to that in a normal airplane, where it is mounted on the floor of the cabin, but the effect is just the same; that is, to say, pushing the column forward has the effect of pushing the aircraft down, and vice versa. A fore-and-aft bias is fitted, which trims the autogiro, much in the same way as the shock-absorber cord-loading device trims some light aircraft, but it does not have the disadvantage of giving an entirely false feel to the controls. A lateral bias is also arranged to overcome any tendency of the aircraft to wander from the straight path laterally and directionally.

At this stage it is probably as well to explain that the rotor is not driven by the engine, but once the aircraft is in the air it rotates of its own accord, hence its name "autogiro." Before the autogiro can fly, however, it is necessary to start up the rotor, and for this purpose there is a shaft drive, operating through a clutch and gearing, from an extension on the back of the engine (fig. 7). Immediately the throttle is opened wide for taking off, the rotor clutch is withdrawn, and from then on the rotor operates entirely automatically. The blades have free movement through several degrees in the vertical plane, and a very much smaller movement in the plane of rotation. This latter movement is controlled by friction

dampers. Motion in the vertical plane is necessary for aerodynamical reasons and allows the forward-traveling blade to rise and the rearward-traveling blade to fall. This movement is also immediately apparent when an autogiro at rest is compared with one in the air. When stationary it will be seen that the blades droop considerably, whereas in movement they assume a very definite coning angle (fig. 9). Two of the blade hinges are arranged so that the corresponding blades may be folded back when a release pin is pulled out, and thus the autogiro can, when necessary, be housed in a very narrow space (fig. 10). The blades themselves have a long steel tube spar, ply-faced spruce ribs, and plywood covering 0.03937 inch thick, the extreme tip being shaped from solid balsa wood. The rotor head itself is a straightforward engineering job, running on ball bearings and incorporating a Bendix brake which allows the blades to be locked when not in use.

Briefly, the blades are arranged aerodynamically so that the resultant of the lift and drag forces acts upon them in a slightly forward direction. The effect is to pull the blades around, and the centrifugal force keeps them extended. One of the great advantages of this system is that the speed of the blades through the air is, within limits, not dependent upon the speed of the whole aircraft through the air. There can, therefore, never be any sudden loss of lift due to the flying speed dropping too low, as whatever the rate of progress of the aircraft, the blades still rotate at their correct speed. Thus, the air flow over them is unchanged and the lift remains the same. The reader will appreciate from this explanation why a vertical descent is possible with the autogiro and not with the normal aircraft, as the latter is dependent upon its speed through the air for air speed over its lifting surfaces.

CHARACTERISTICS

Dimensions:

| | | |
|--------------------------|---------|----------------|
| Diameter of rotor circle | 11.28 m | 37 ft. 0 in. |
| Height, over-all | 3.36 " | 11 " 0-3/4 in. |
| Length, over-all | 6.01 " | 19 " 8-1/2 " |
| Wheel track | 2.74 " | 9 " 0 in. |
| Span of tail plane | 3.10 " | 10 " 2 " |

Areas:

| | | |
|----------------------|---------------------|-------------|
| Tail plane | 1.45 m ² | 15.6 sq.ft. |
| Upturned tips (both) | .84 " | 8.55 " |
| Upper fin | 1.20 " | 12.9 " |
| Lower fin | .38 " | 3.38 " |
| Rotor blade (each) | 1.45 " | 15.6 " |

Weights (458.66 km =
285 miles range):

| | | |
|------------------------------------|-----------|----------|
| Tare weight | 553.38 kg | 1220 lb. |
| Crew (two) | 149.69 " | 330 " |
| Fuel (23 gallons) | 80.28 " | 177 " |
| Oil (3½ gallons) | 14.51 " | 32 " |
| Baggage | 18.60 " | 41 " |
| Gross weight (maximum permissible) | 816.46 " | 1800 " |

Performance:

| | | |
|---------------------------|-------------|------------|
| Speed at sea level (max.) | 177.03 km/h | 110 m.p.h. |
| Cruising speed | 152.89 " | 95 " |

Performance (continued):

| | | |
|--------------------------------|------------|--------------|
| Minimum flying speed, about | 24.14 km/h | 15 m.p.h. |
| Landing speed | | 0 |
| Take-off run | 10.97 m | 12 yd. |
| Landing run | | 0 |
| Rate of climb (initial) | 3.56 m/s | 700 ft./min. |
| Ceiling | 3657.6 m | 12000 ft. |

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Fig. 1

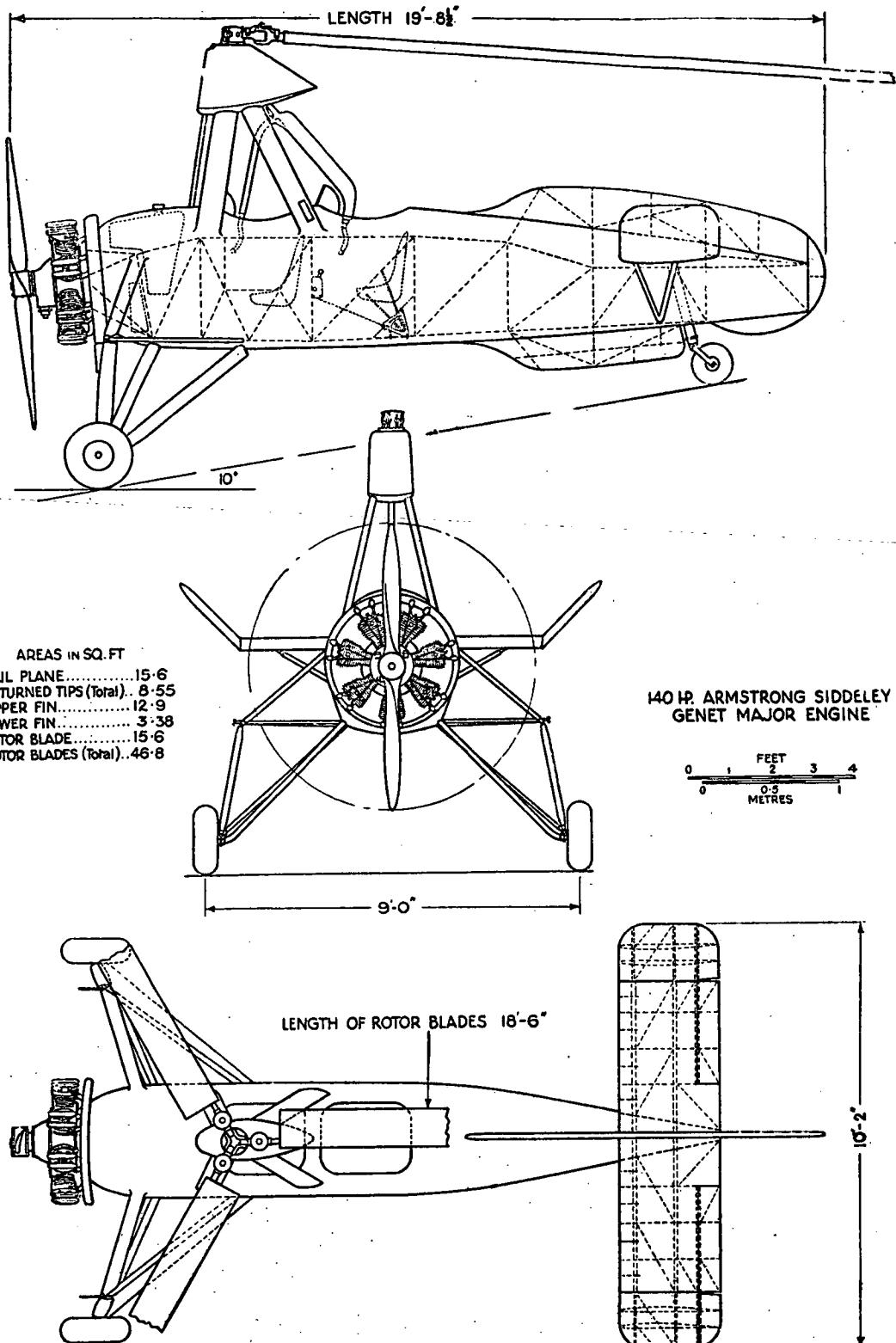


Figure 1.- General arrangement drawing of the C. 30 autogiro.

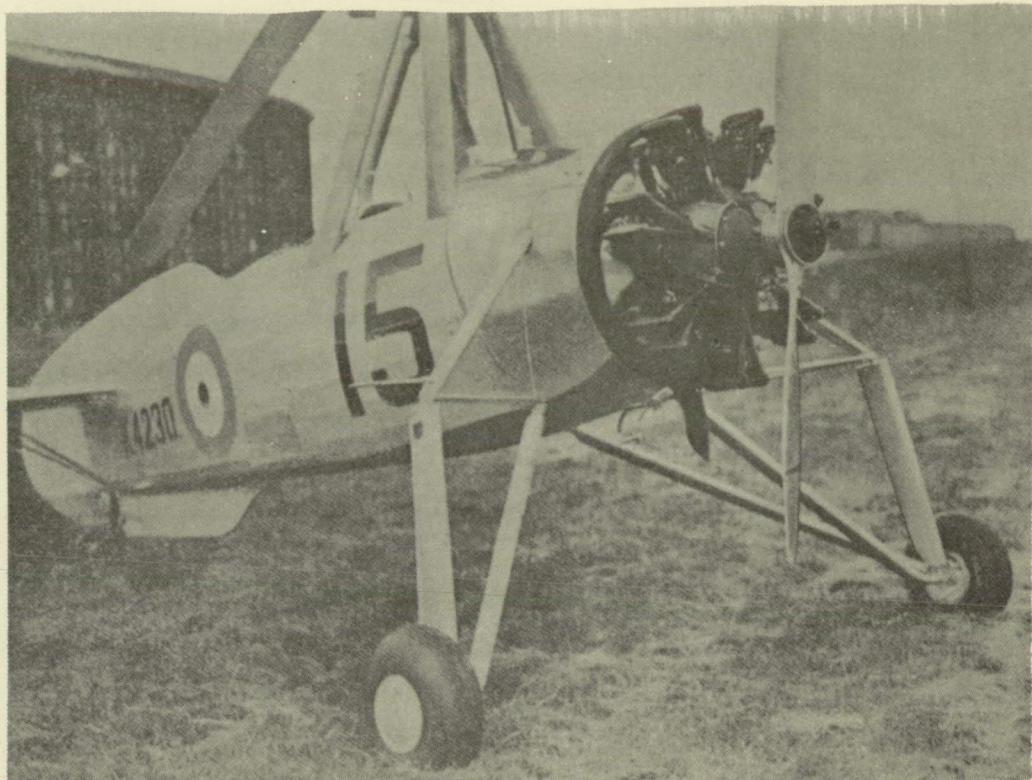


Figure 2.- Wide landing gear with long travel compression legs, necessary for vertical landing of autogiro.

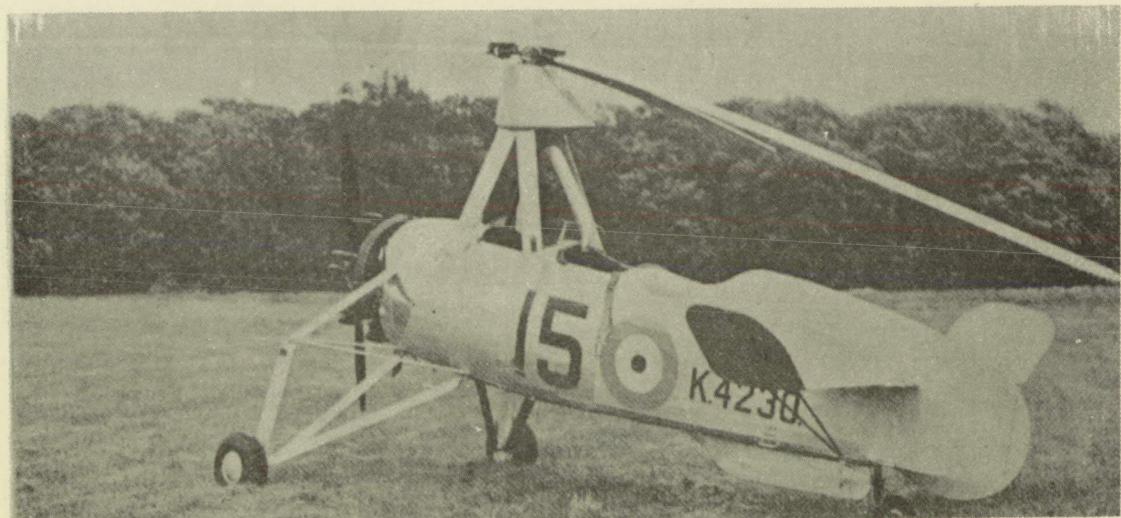


Figure 3.- The first of the Avro C 30a autogiros ready for delivery to the Royal Air Force for army co-operation work.

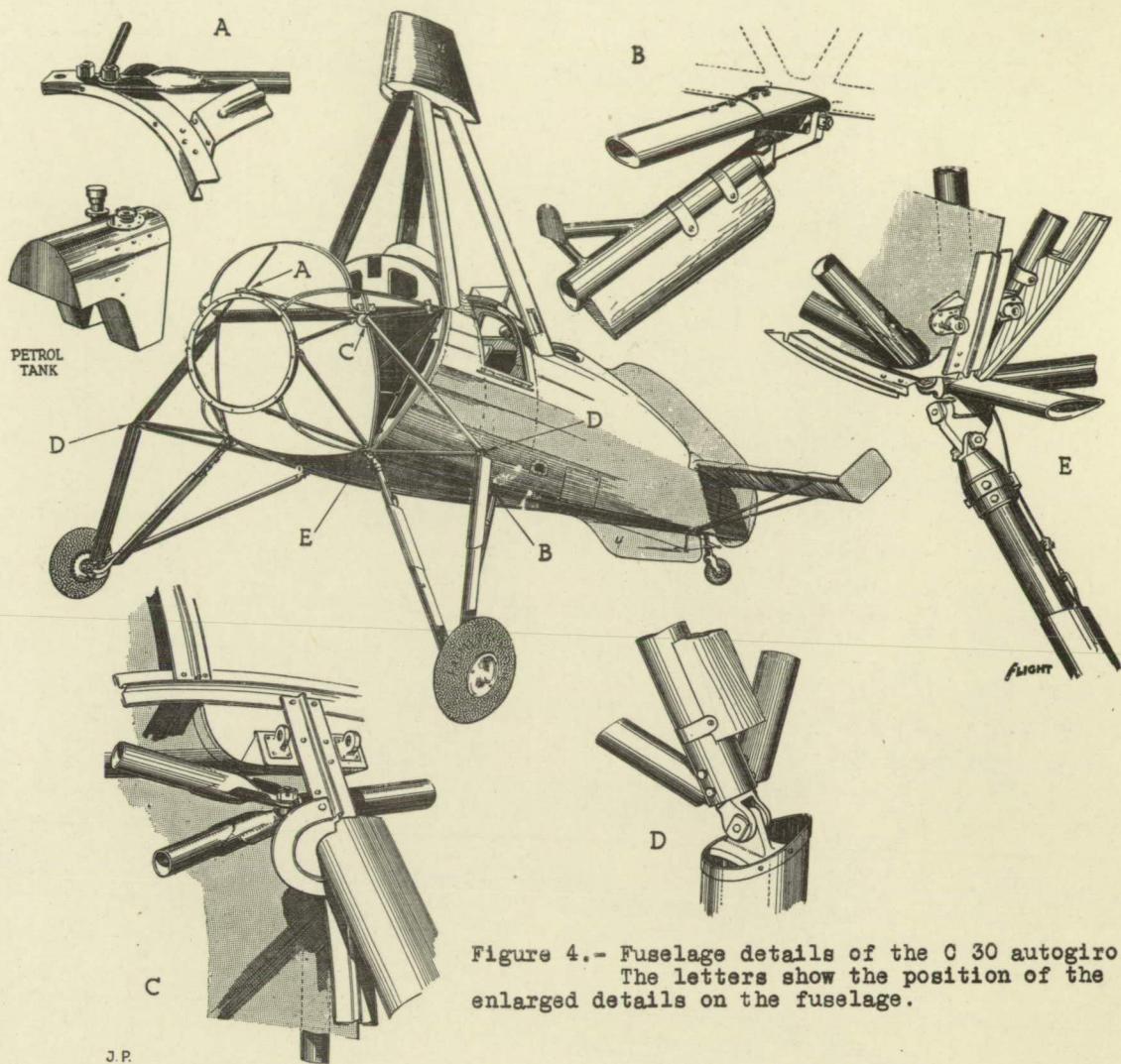


Figure 4.- Fuselage details of the C 30 autogiro.
The letters show the position of the
enlarged details on the fuselage.

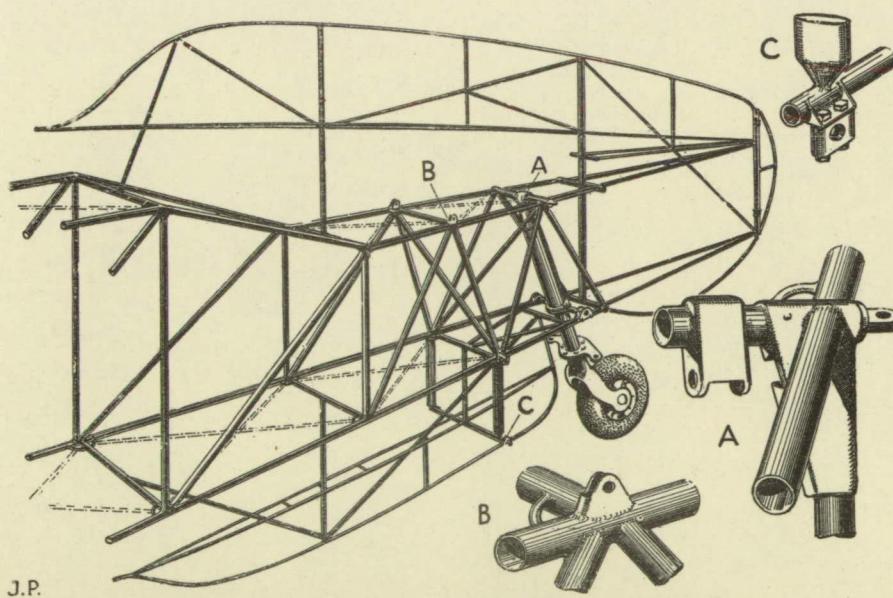


Figure 5.-
Welded
construction.
The rear of
the fuselage
with the
tail wheel
mounting

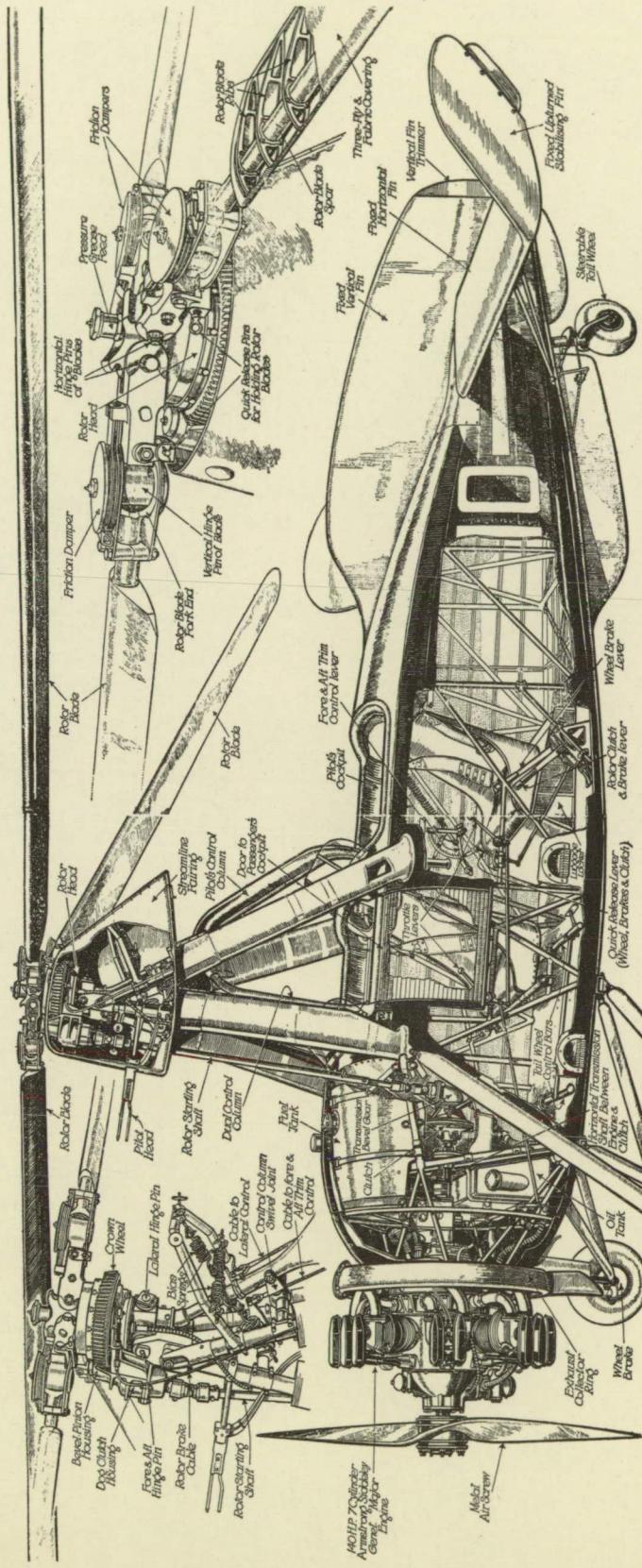


Figure 7.—A graphic illustration of the C 30 autogiro.

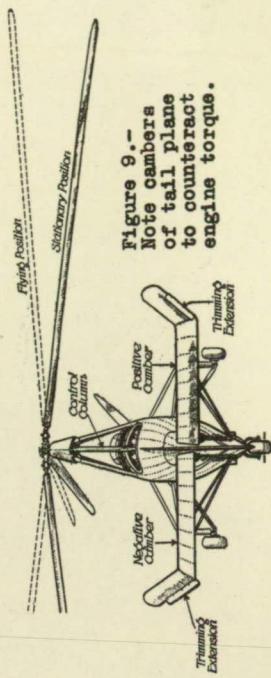


Figure 9.—
Note camber
of tail plane
to counteract
engine torque.

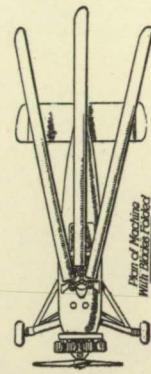


Figure 10.—Two of the blades may be folded on their hinges to enable the aircraft to be housed in a small space.

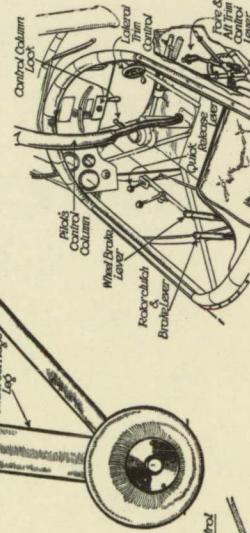


Figure 8.—Direct control. Diagrammatic views showing the way in which the rotor head is tilted.

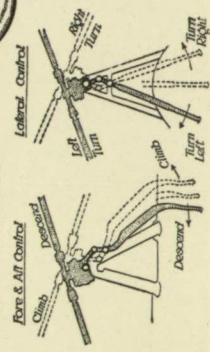


Figure 6.—View of the cockpit showing the flying controls confined to a single "hanging" stick, the foot bar being used for operating the tail wheel when the aircraft is taxiing.